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LISTS OF SPECIES

Check List 13(2): 2081, 3 April 2017 doi: https://doi.org/10.15560/13.2.2081
ISSN 1809-127X © 2017 Check List and Authors

Pteridophytic diversity in human-inhabited buffer zone of Murlen National Park, Mizoram, India

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Abstract: A taxonomic inventorization of pteridophytes occurring in a human inhabited buffer zone of Murlen National Park, India, was conducted in 2012 and 2013. This survey revealed 35 species belonging to 27 genera and 15 families. Polypodiaceae was recorded as dominant family, represented by six genera and eight species, followed by Pteridaceae (three genera and six species) and Lycopodiaceae (three genera and four species). Of the recorded species, 23 species were terrestrial, 11 (epiphytic) and two (lithophytic) in their habit forms. The species richness was highest in Tualpui village, with 11 species, followed by Rabung (7) and Ngur (6). The site preference of species among the villages is discussed. These data will provide baseline for future research and monitoring of pteridophytic vegetation in this protected area, as well as in similar habitats in the adjacent areas.

Key words: Indo-Burma biodiversity hotspot; *Jhum* cultivation; Pteridophytes

INTRODUCTION

Pteridophytes are the second largest group of vascular plants with about 13,600 species (Moran 2008) distributed throughout the world except in Arctic, Antarctic zones and oceans. They are an important seral stage in the biological successional process of the earth. The majority of pteriodophyte species are concentrated in tropical rain forests and, in general, their richness decreases poleward from the equator (Moran 2008). However, in the Himalaya and southeastern China this rule of latitudinal fern diversity gradient deviates (Kholia 2011a). Gigantic tree-like pteridophytes were the dominant vegetation during the Mesozoic era. In the Holocene, flowering plants replaced pteridophytes, but the latter are still the major vegetation in many forests where their diversity is manyfold higher than the other group of plants. In other forests, they forms understory vegetation (Kholia 2010a). They are sometimes considered to be indicators of forest health (Kholia 2014). Generally, it is believed that modern ferns and their allies are much older than flowering plants, and often considered as living fossils, but except for a few families, most of the modern ferns evolved and flourished under the shadow of angiosperms (Smith et al. 2006).

In India, pteridophytes are mainly distributed in Himalayan region, as well as North-Eastern and Southern India, where climates are humid and more conducive for growth. Approximately 1,267 species of pteridophytes (ca. 9% of global species) are recorded from the country (Singh & Dash 2014). The highest number (ca. 700 species) of pteridophytes occurs in the Eastern Himalaya and adjoining states, making this region a biodiversity hotspot for pteridophytes (Dixit 2000).

The North-Eastern Region of India, which is comprised of seven sister states, is part of the Indo-Burma biodiversity hot spot (Meyers 2000; Conservation International 2011). Well known for its rich biological diversity, the region has been extensively explored in terms of pteridophytic flora by several workers. Baishya & Rao (1982) recorded 256 species of fern and fern allies in Meghalaya; Jamir & Rao (1988) reported 280 species from Nagaland; Borthakur et al. (2000) confirmed the presence of 221 species in Assam; and Kholia (2010a, 2011b, 2014) reported 480 species from Sikkim.

Mizoram, a hilly state having an area of ca. 21,000 km^2 and part of the North-East Region, is within the biogeographic province 9B (Rodgers et al. 2000). *Jhum* cultivation, also known as shifting cultivation, is the main system of agriculture in Mizoram, covering an area of ca. 300 km^2. Due its biogeography, physiognomy, climate, and vegetation, this state has ideal habitats for both mesophytic and epiphytic pteridophytes. However, pteridophytic diversity is poorly explored in the state, except with few efforts (Barbhuiya & Singh 2014; Benniamin 2012; Sharma et al. 2013; Vanlalpeka & Laha 2014, 2015; Verma et al. 2013, 2014.

Situated in Mizoram, adjacent to the Indo-Myanmar

Figure 1. Map of the study area showing the location of villages (blue dots).

border, Murlen National Park (MNP) is significant for its proximity to the Chin Hills (Myanmar). It is an important area for floristic diversity, but has not had adequate attention by researchers. Apart from habitat degradation by *Jhum* cultivation, cane extraction, and occasional tree cutting, the hunting of larger vertebrates and birds are threats to this park (Kaul et al. 1996). A preliminary list of pteridophytes of MNP by Benniamin (2012) was based on a single visit and did not include human-inhabited areas. Despite the efforts to study the pteridophytic diversity in the region, few studies included the equally important peripheral and buffer areas having high human interference. Therefore, this study focuses on documenting the pteridophytes in and around human inhabitations within the buffer zone of Murlen National Park, Mizoram, India.

MATERIALS AND METHODS

Study site

Located in Champhai district, Mizoram (21°57′N to 24°30′N, 092°15′E to 093°29′ E), MNP is characterized by dense tropical to subtropical evergreen mixed forests (Figure 1). Spreading over an area of ca. 200 km^2 with an elevation range between 600–1,800 m, the park has several small seasonal and perennial streams. Physiographically, the park is characterized by undulating topography and rugged mountains. It receives an annual rainfall of 2,000–2,500 mm. The temperature ranges between 5°C winter to 35°C in summer.

In this study six villages within the buffer area of MNP were surveyed: Rabung, Tualpui, Ngur, Vapar, North Khawbung, and Murlen. The trail which connects these villages to the surrounding park makes vegetation vulnerable due to anthropogenic disturbances. These villages harbour deciduous or evergreen mixed secondary forest with enormous human pressure. Most of the forests in these villages are under *Jhum* cultivation (slash and burn). This practice has affected the structure and function of natural vegetation in these villages as well as in the National Park.

Data collection

A systematic survey of pteridophytes was made in 2012 and 2013 by traversing on foot all the pteridophytic habitats in and around peripheral village forests, nearby *Jhum* fields, water channels, ridges and various habitats in and around the forests. The inventory was also carried out along existing trails near human habitations.

To facilitate identification, elevation and important taxonomic characters, including life form and habitat of the species, were also gathered. Identifications of specimens were based on field characters with the aid of existing literature (Baishya & Rao 1982; Jamir & Rao 1988; Kholia 2010a, 2014; Benniamin 2012; Table 1) and checked against authentic specimens housed in the herbarium of Botanical Survey of India, Eastern Regional Centre, Shillong (ASSAM). Voucher specimens were dried, pressed, and mounted on herbarium sheets following Jain & Rao (1976) and deposited in the ASSAM herbarium.

Data analysis

The taxonomy of recorded species follows Fraser-Jenkins (2009). Species are listed in Table 1, along with spore producing period (fertile period), voucher specimens, and general distribution. Species richness was determined as the total number of species in an area. The general distributions of species is based on Dixit (1984) and Kholia (2010a, 2014).

RESULTS

In this survey, 35 species belonging to 27 genera and 15 families were found (Table 1). Polypodiaceae was found to be the dominant family, represented by six genera and eight species, followed by Pteridaceae (3 genera and 6 species) and Lycopodiaceae (3 genera and 4 species; Figure 2). The dominant genus was *Pteris* L. with four species (*Pteris biaurita* L. (Linnaeus 1753: 1076), *Pteris cretica* L. (Linnaeus 1767: 130), *Pteris pellucida* C.Presl (Presl 1825: 55), and *Pteris vittata* L. (Linnaeus 1753: 1074)) followed by *Huperzia* Bernh., *Microsorum* Link, *Pyrrosia* Mirb., *Lygodium* Sw., and *Tectaria* Cav. with two species each. Of the recorded species, 23 species were terrestrial, 11 epiphytes, and two lithophytes, viz., *Microsorum membranaceum* (D.Don) Ching (Don 1825: 2; Ching 1933: 309)

Table 1. Pteridophytes of Murlen National Park, Mizoram, northeast India with their family, habit form, fertile time, village of collection, exsiccata and nativity.

Family and species	Life form	Fertile time	Village of collection	Voucher specimen (with date)	General distribution	Identification reference
Lycopodiaceae						
Huperzia serrata (Thunb.) Trevis.	Terrestrial	Nov.–July	Murlen	Sachin Sharma; 128150; 25.01.2013	Southeast Asia; Tropical America	Baishya & Rao 1982
Huperzia squarrosa (G.Forst.) Trevis.	Epiphytic	June–Sep.	Tualpui	Sachin Sharma; 127274; 25.09.2012	Southeast Asia; French Polynesia	Kholia 2010a
Lycopodiella cernua (L.) Pic.Serm.	Terrestrial	Sept.–Nov.	Rabung	Sachin Sharma; 128807; 21.09.2012	Tropical-subtropical world	Kholia 2010a
Lycopodium japonicum Thunb.	Terrestrial	Sept.– Feb.	Vapar	Sachin Sharma; 128500; 15.04.2013	Indo-China; Japan	Kholia 2010a
Marattiaceae						
Angiopteris indica Desv.	Terrestrial	July– Nov.	Tualpui	Sachin Sharma; 129862; 25.09.2014	Indo-China; Polynesia	Kholia 2010a
Equisetaceae						
Equisetum ramosissimum subsp. *debile* (Roxb. ex Vaucher) Hauke	Terrestrial	Sept. – Nov.	Ngur	Sachin Sharma; 128244; 19.01.2013	Southeast Asia	Kholia 2014
Selaginellaceae						
Selaginella pentagona Spring	Terrestrial	Sept. – Nov.	Tualpui	Sachin Sharma; 129225; 20.09.2012	Indo-China	Baishya & Rao 1982
Gleicheniaceae						
Dicranopteris lanigera (D.Don) Fraser-Jenk.	Terrestrial	Oct. –Feb.	Vapar	Sachin Sharma; 129825; 06.03.2014	Tropical Asia; Africa; Madagascar	Kholia 2010a
Polypodiaceae						
Drynaria propinqua (Wall. ex Mett.) J.Sm. ex Bedd.	Epiphyte	May– Oct.	Rabung	Sachin Sharma; 127249; 21.09.2012	Southeast Asia	Kholia 2010a
Lepisorus nudus Ching	Lithophyte	Oct.– Feb.	Rabung	Sachin Sharma; 127235; 21.09.2012	Southeast Asia; Central and Southern Africa; Madagascar	Baishya & Rao 1982
Leptochilus pteropus (Blume) Fraser-Jenk.	Terrestrial	Dec.– Feb.	Murlen	Sachin Sharma; 128136; 15.01.2013	Tropical Asia	Kholia 2014
Microsorum membranaceum (D.Don) Ching	Lithophyte	Sept.– Feb.	Vapar	Sachin Sharma; 127375; 26.09.2012	Indo-China; Sri Lanka	Kholia 2010a
Microsorum punctatum (L.) Copel.	Epiphyte	Nov.– Feb.	Ngur	Sachin Sharma; 128046; 13.01.2013	Tropical Asia; Africa	Kholia 2010a
Pseudodrynaria coronans (Wall. ex Mett.) Ching	Epiphyte	July– Feb.	Tualpui	Sachin Sharma; 127222; 20.09.2012	Southeast Asia; Formosa	Kholia 2010a
Pyrrosia flocculosa (D.Don) Ching	Epiphyte	Feb.– Apr.	Vapar	Sachin Sharma; 129956; 28.02.2014	Southeast Asia	Kholia 2010a
Pyrrosia mannii (Giesenh.) Ching	Epiphyte	May– July	Murlen	Sachin Sharma; 128151; 15.01.2013	Southeast Asia	Kholia 2010a
Lygodiaceae						
Lygodium flexuosum (L.) Sw.	Terrestrial	May– Oct.	Ngur	Sachin Sharma; 129816 05.03.2014	Southeast Asia; Australia; Pacific islands	Kholia 2010a
Lygodium japonicum (Thunb.) Sw.	Terrestrial	May– Oct.	Tualpui	Sachin Sharma; 129820 25.09.2014	Southeast Asia; Japan; Tropical/subtropical America	Kholia 2010a
Pteridaceae						
Adiantum philippense L.	Terrestrial	July– Oct.	Rabung	Sachin Sharma; 127233; 21.09.2013	Pantropical	Kholia 2010a
Onychium siliculosum (Desv.) C.Chr.	Terrestrial	May– Oct.	Ngur	Sachin Sharma; 129975; 04.03.2014	Southeast Asia; Polynesia	Kholia 2010a
Pteris biaurita L.	Terrestrial	May– Oct.	Tualpui	Sachin Sharma; 128807; 21.09.2014	Tropical/subtropical world	Kholia 2010a
Pteris cretica L.	Terrestrial	May– Oct.	Tualpui	Sachin Sharma; 128160; 15.01.2013	Tropical/temperate world	Kholia 2010a
Pteris pellucida C.Presl	Terrestrial	July– Oct.	Vapar	Sachin Sharma; 129953; 28.02.2014	India; Burma; Malay island	Jamir & Rao 1988
Pteris vittata L.	Terrestrial	July– Oct.	Murlen	Sachin Sharma; 127429; 27.09.2012	Tropical/subtropical world	Kholia 2010a
Dennestaedtiaceae						
Microlepia puberula Alderw.	Terrestrial	Oct.– Dec.	Tualpui	Sachin Sharma; 129838; 07.03.2014	Indo-China; Java	Baishya & Rao 1982
Pteridium aquilinum (L.) Kuhn	Terrestrial	July– Nov.	Rabung	Sachin Sharma; 127243; 21.09.2013	Tropical/subtropical world	Kholia 2010a
Sphenomeris chinensis (L.) Maxon	Terrestrial	July– Dec.	Rabung	Sachin Sharma; 129823; 06.03.2014	Southeast Asia, East Africa	Kholia 2010a
Thelypteridaceae						
Thelypteris xylodes (Kunze) Ching	Terrestrial	July– Dec.	Rabung	Sachin Sharma; 127244; 21.09.2013	Southeast Asia	Kholia 2014

Continued

Table 1. *Continued.*

Family and species	Life form	Fertile time	Village of collection	Voucher specimen (with date)	General distribution	Identification reference
Aspleniaceae						
Asplenium phyllitidis D.Don	Epiphyte	July– Dec.	North khawbung	Sachin Sharma; 128277; 18.01.2013	Indo-China; Japan	Kholia 2010a
Dryopteridaceae						
Tectaria fuscipes (Wall. ex Bedd.) C.Chr.	Terrestrial	Oct.– Jan.	Tualpui	Sachin Sharma; 128022; 11.01.2013	Southeast Asia	Kholia 2010a
Tectaria polymorpha (Wall. ex Hook.) Copel.	Terrestrial	Oct.– Dec.	Tualpui	Sachin Sharma; 127219; 20.09.2013	Southeast Asia	Kholia 2010a
Blechnaceae						
Blechnum orientale L.	Terrestrial	Oct.– Feb.	Ngur	Sachin Sharma; 129991; 04.03.2014	Southeast Asia; Australia	Kholia 2010a
Brainea insignis (Hook.) J.Sm.	Terrestrial	Nov.– Mar.	Ngur	Sachin Sharma; 129987; 04.03.2014	Southeast Asia	Kholia 2010a
Athyriaceae						
Diplazium esculentum (Retz.) Sw.	Terrestrial	July– Feb.	North khawbung	Sachin Sharma; 128705; 09.03.2014	Southeast Asia	Kholia 2010a
Vittariaceae						
Vittaria elongata Sw.	Epiphyte	Feb.–Dec.	Tualpui	Sachin Sharma; 128141; 15.01.2013	Southeast Asia; Australia; Africa	Kholia 2014

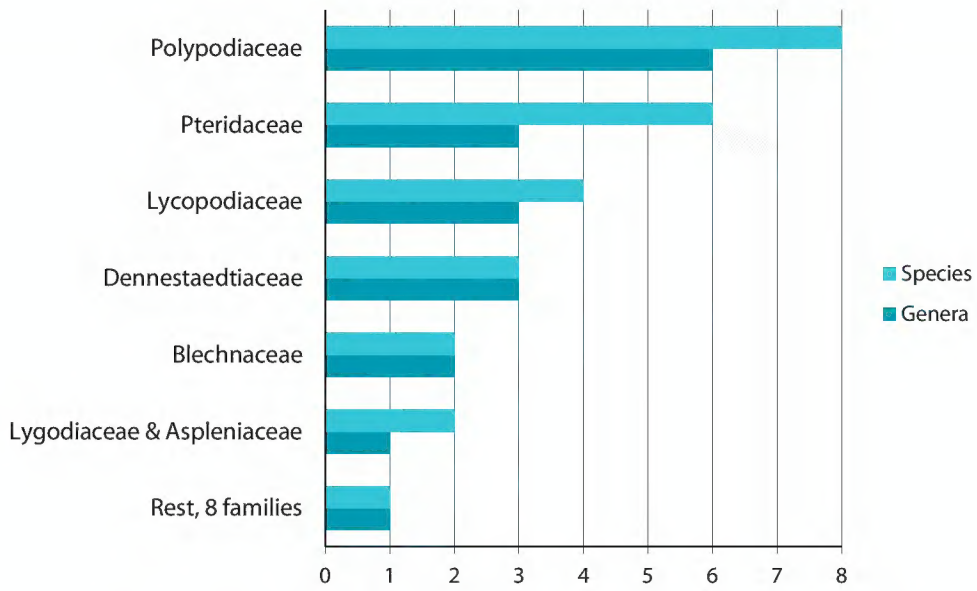

Figure 2. Dominant families with their respective number of genera and species in Murlen National Park, Mizoram, North-East India.

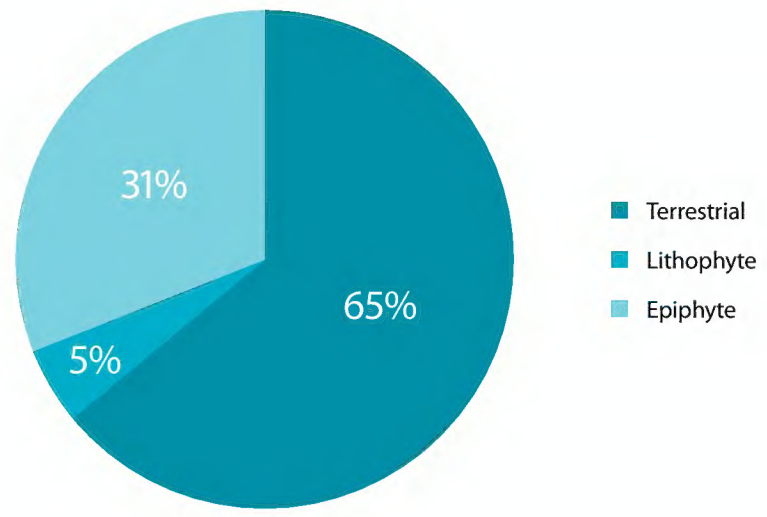

Figure 3. Contribution of different life forms recorded in Murlen National Park, Mizoram, North-East India.

and *Lepisorus nudus* Ching (Ching 1933: 83; Figure 3). The species richness was highest in Tualpui village (11 species) followed by Rabung village (7 species) and Ngur village (6 species). *Lycopodiella cernua* (L.) Pic.Serm. (Linnaeus 1753: 1103; Pichi Sermolli 1968: 166), *Dicranopteris lanigera* (D.Don) Fraser-Jenk. (Don 1825: 17; Fraser-Jenkins 2008: 35), *Lepisorus nudus*, *Pseudodrynaria coronans* (Wall. ex Mett.) Ching (Mettenius 1856: 121; Ching 1940: 262), *Pyrrosia flocculosa* (D.Don) Ching (Don 1825: 1–2; Ching 1935: 66), *Lygodium flexuosum* (L.) Sw. (Linnaeus 1753: 1063; Swartz 1801: 106), *Onychium siliculosum* (Desv.) C.Chr. (Desvaux 1811: 324; Christensen 1905: 469), *Pteris biaurita*, *Pteris vittata,* and *Pteridium aquilinum* (L.) Kuhn (Linnaeus 1753: 1075; Kuhn 1879: 11) occurred in xeric, open places. *Diplazium esculentum* (Retz.) Sw. (Retzius 1791: 38; Swartz 1803: 312) was used by local inhabitants as a vegetable. An overview of the study area with some species and specific habitats are shown in Figures 4 and 5.

DISCUSSION

In general, most of ferns and fern allies prefer shady, humid places because prolonged water availability is necessary for reproduction and growth. The relatively high species richness in Tualpui and Rabung villages is likely attributed to position of these villages along rivers. In contrast, Ngur and Vapar villages are on hill tops with exposed conditions where strong winds affect atmospheric humidity and conditions remain relatively dry. Moreover, spores would be washed downstream and bare slopes under *Jhum* cultivation have little water holding capacity. Hence, the spore germination is expected to be poor in these villages.

Most of the species found were fertile during May to October, as ferns need moisture for germination of their spores and to grow. However, *Brainea insignis* (Hook.) J.Sm. (Hooker 1853: 237–238; Smith 1856: 5) is fertile from November to March. This pre-monsoon fertility may be an adaptation to avoid competition. This species gets water from north-east monsoon (winter rains) or stored moisture in its caudex. Also, *Vittaria elongata* Sw. (Swartz 1806: 109, 302) is fertile from February to December, which includes a few pre-monsoon months.

Species such as *Lycopodiella cernua, Dicranopteris lanigera, Drynaria propinqua* (Wall. ex Mett.) J.Sm. ex Bedd. (Mettenius 1856: 120; Beddome 1866: 160), *Pyrrosia*

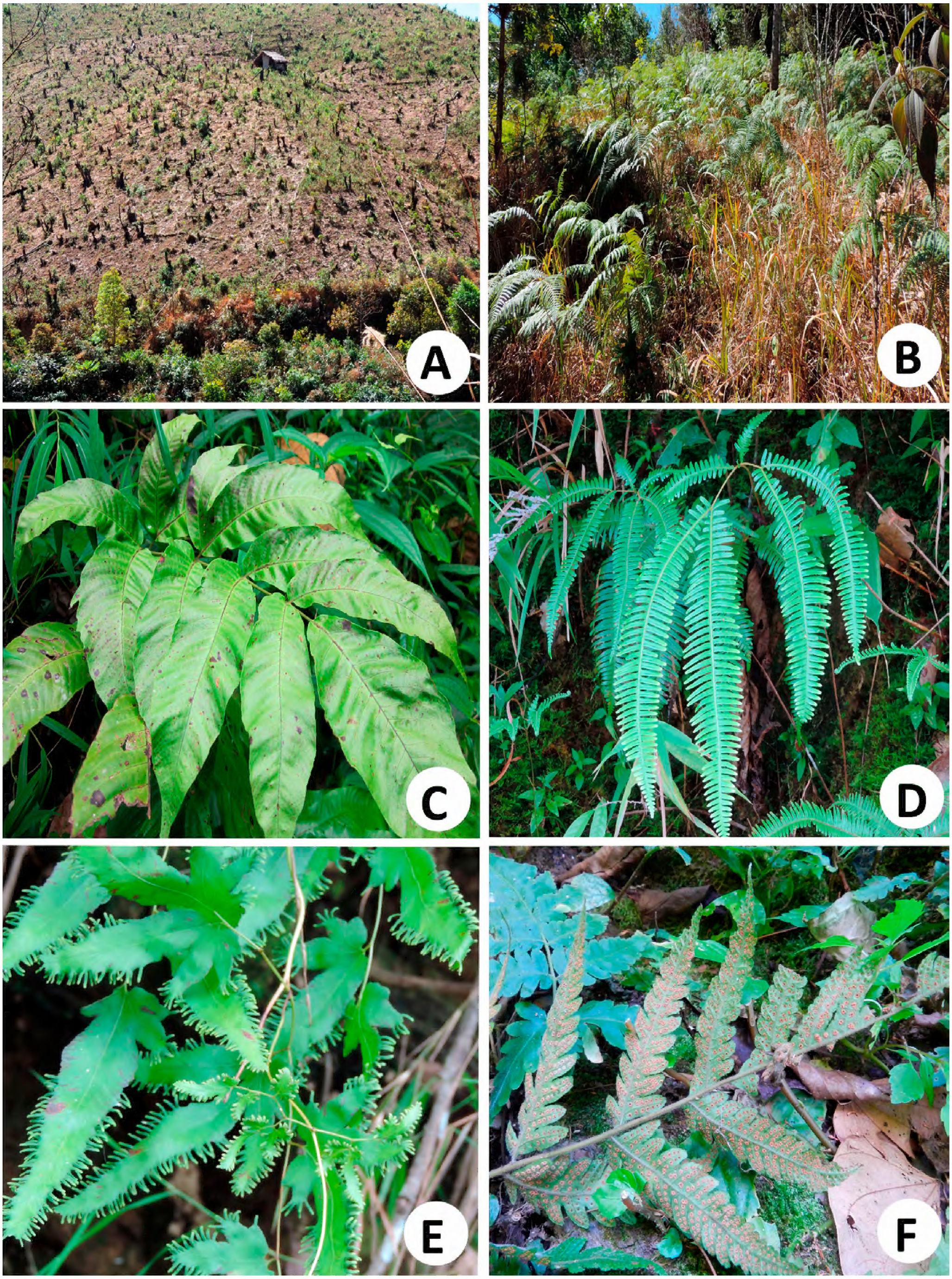

Figure 4. A. Shifting cultivation in study area. **B.** Invasion of obnoxious weedy fern *Pteridium aquilinum* in old *Jhum* fields. **C.** *Tectaria polymorpha* growing in open grass fields along road cuttings. **D.** *Dicranopteris lanigera* growing in disturbed land. **E.** *Lygodium flexuosum* climbing in bushes in old *Jhum* area. **F.** *Tectaria fuscipes* growing on slopes near stream.

Figure 5. A. Frond of *Pteridium aquilinum*. **B.** Fertile part of *Lygodium japonicum*. **C.** Population of *Thelypteris xylodes*. **D.** A frond of *Diplazium esculentum*. **E.** *Huperzia serrata*. **F.** *Equisetum ramosissimum* subsp. *debile*.

flocculosa, *Lygodium japonicum* (Thunb.) Sw. (Thunberg 1784: 926; Swartz 1801: 106), *Adiantum philippense* L. (Linnaeus 1753: 1094), *Pteris biaurita*, and *Pteris vittata* were common along roadsides and paths in the villages. *Huperzia serrata* (Thunb.) Trevis. (Thunberg 1784: 944; Trevisan de Saint-Léon 1874: 248), *Angiopteris indica* Desv. (Desvaux 1811: 307), *Equisetum ramosissimum* subsp. *debile* (Roxb. ex Vaucher) Hauke (Vaucher 1822: 387; Hauke 1962: 33), *Microsorum membranaceum*, *Tectaria fuscipes* (Wall. ex Bedd.) C.Chr. (Beddome 1876: 15; Christensen 1931: 290) and *Tectaria polymorpha* (Wall. ex Hook.) Copel. (Hooker 1862 : 54–55; Copeland 1907: 413) were observed along the water channels, while *Diplazium esculentum*, *Brainea insignis*, and *Asplenium phyllitidis* D.Don (Don 1825: 7) were reported in and around kitchen gardens. *Angiopteris indica*, *Equisetum ramosissimum* subsp.

debile, *Selaginella pentagona* Spring (Spring 1850: 150), *Leptochilus pteropus* (Blume) Fraser-Jenk. (Blume 1828: 125; Fraser-Jenkins 2008: 62), *Pteris pellucida*, *Microlepia puberula* Alderw. (Alderwerelt van Rosenburgh 1913: 17), *Thelypteris xylodes* (Kunze) Ching (Kunze 1851: 281; Ching 1936: 296–298), *Asplenium phyllitidis*, *Tectaria fuscipes*, *T. polymorpha*, *Blechnum orientale* L. (Linnaeus 1753: 1077), and *Diplazium esculentum* were found growing in moist, humid places.

Due to these specific habits and characteristic habitats, ferns and their allied plants are often considered as indicator species for climate change. Additionally, anthropological pressures, especially shifting cultivation, burning, frequent pruning, grazing, and tree cutting could lead to the depletion of pteridophytic diversity in MNP. Therefore, management authorities should take steps to protect the pteridophytic wealth of the park. The information presented here can serve as a baseline for the future research and monitoring of pteridophytes in MNP as well as in similar habitats in the adjoining areas.

ACKNOWLEDGEMENTS

The authors are grateful to the Director, Botanical Survey of India (BSI), Kolkata, Dr. A.A. Mao and Dr. S.K. Srivastava H.O.O., BSI, Eastern Regional Centre, Shillong and Northern Regional Centre (NRC), Dehradun, respectively, for providing facilities and encouragement. Mr. Joseph, range officer at Murlen National Park provided logistic support. Thanks are also due to Dr. Brijesh Kumar, BSI, NRC, Dehradun, and the editor, Gustavo Hassemer, for improving the manuscript.

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Authors' contributions: SS contributed to the collection of species, photography, review of literature, data analysis, and writing of the manuscript; RK helped in field data collection; BSK guided the fieldwork and interpretation of data, and helped in identification; AK helped with literature review, data analysis, and the writing the manuscript.

Received: 17 August 2015
Accepted: 31 January 2017
Academic editor: Gustavo Hassemer